

Status of Optics Measurements with Reverse Protons for A1 line

1. Measured transfer functions coincide with the model up to statistical accuracy of the measurements
 - But the following discrepancies were observed
 - ◊ 0.05 mrad kick by correctors T:HE42, T:HE44 , T:VE47 and T:VE49 actually corresponds to 0.046 mrad if we believe that the BPMs are accurate. The difference is ($-8\pm2\%$)
 - ◊ 0.1% energy change (143 Hz of 53 MHz or 2.7 mm in T:VRPTC2) are observed as ($0.087\pm-0.003\%$) at BPMs
 - ⇒ I would rather believe that BPMs are reporting values which are about 10% below of actual beam displacement
 - ◊ This statement is also supported by comparison of BPM measurements in Tevatron with A1 line and MI
 - ⇒ Scaling of main injector BPMs
 - ◊ Vertical BPMs are wired opposite to MI and A1 line
 - ◊ Both vertical and horizontal BPMs report the displacements which are 10 times higher than actual
 - It follows from the measurements that [the emittance dilution due to optics mismatch does not exceed 10-20%](#)
 - ⇒ It can be measured by observing the emittance growth with reverse proton injection to Tevatron and then back to MI
 - ⇒ Final tuning can be done with minimizing beam emittance using assigned A1 quads.
2. Measurements of dispersions
 - Horizontal dispersion in Tevatron is different from design by about 7%
 - Due to coupling the vertical dispersion is excited. Its value is about 10% of the horizontal one or ~0.6 m at peaks
 - [The emittance dilution due to dispersion mismatches is about 1.5%](#) ($\epsilon_{n95\%} = 20 \text{ mm mrad}$, $\Delta p/p_{95\%} = 0.001$)
3. Coupling
 - Due to coupling there is a response in other plane about 20% of initial kick
 - ⇒ [Coupling yields the emittance dilution of 2%](#)

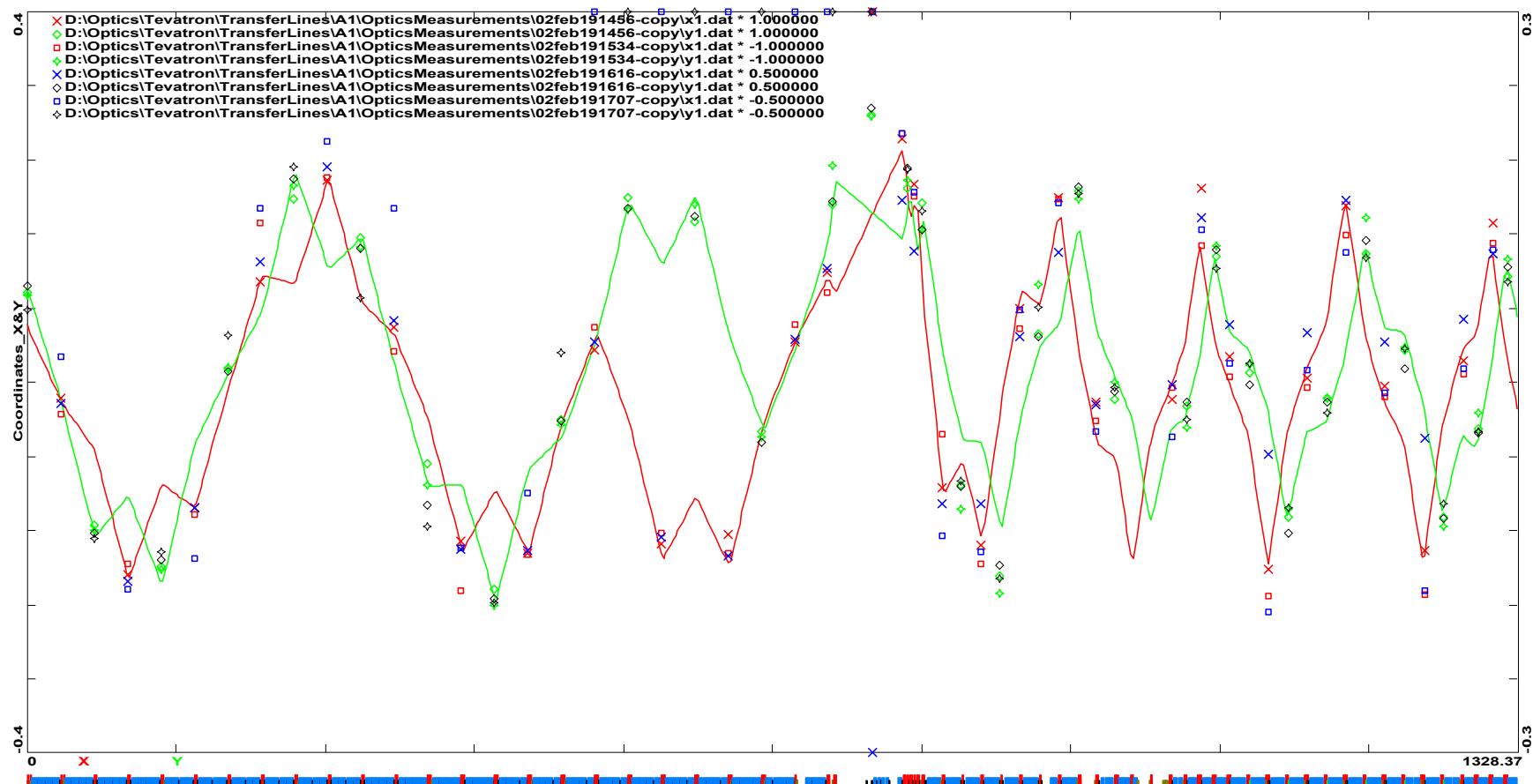
4. Scraping

- Poor accuracy of BPM intensity signals limits a possibility to detect scraping below 20-30%
 - ⇒ Scraping was not visible at intensity signals of BPMs
 - ⇒ But direct observations of beam current changes in Tevatron and MI verified that the beam scraping in A1 line did not exceed 30% with orbit bumps up to 3 mm which is equal to the 95% beam size
 - ◊ That yields that [there is about \$4\sigma\$ or 5 mm between the beam center and closest piece of vacuum chamber in A1 line.](#)
 - ◊ Unfortunately the accuracy of the measurements does not allow to determine where this scraping does occur
- There is very tight vertical aperture in the Tevatron
 - ⇒ -0.05 mrad excitation of T:VE49 causes 30% scraping in the Tevatron
 - ⇒ -0.1 mrad excitation of T:VE49 causes completely kills the beam
 - ⇒ 0.1 mrad excitation of T:VE49 does not produce visible scraping
 - ◊ That determines that the free vertical aperture does not exceed 2.5σ or 3 mm.
 - ◊ There is at least 5σ vertical aperture in the opposite direction which almost certainly means that the vertical beam resteering can solve the problem

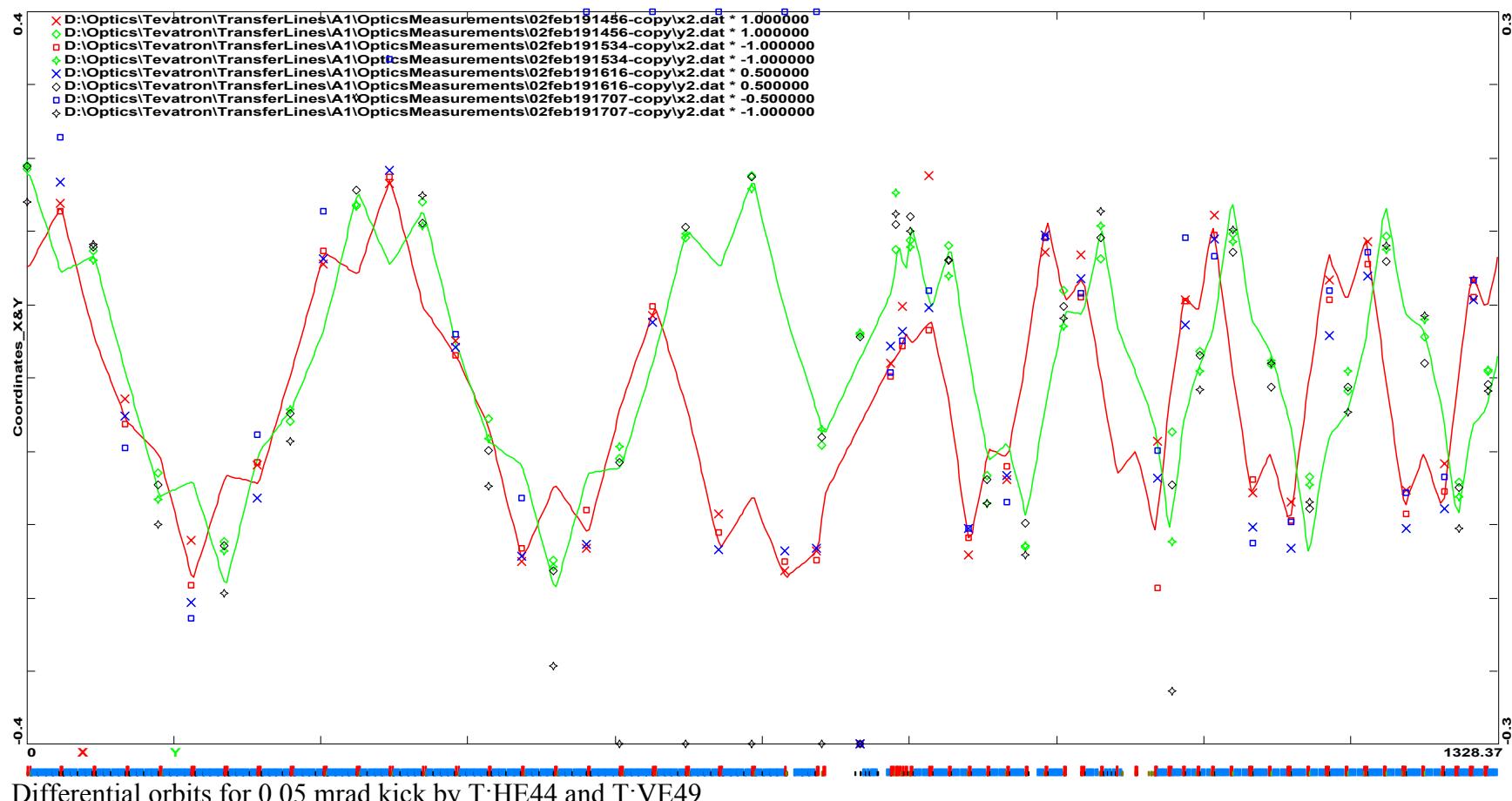
5. Suggested action items

- Using local bumps find and fix the aperture limitation in the Tevatron
- Differential orbit measurements with the excitation of larger amplitude (5-8 mm) at the beginning of A1 line (counting from TEV) will allow to point out where the scraping in A1 line does occur
- Verify by direct measurements that BPMs are scaled wrong and, then, correct BPM scaling

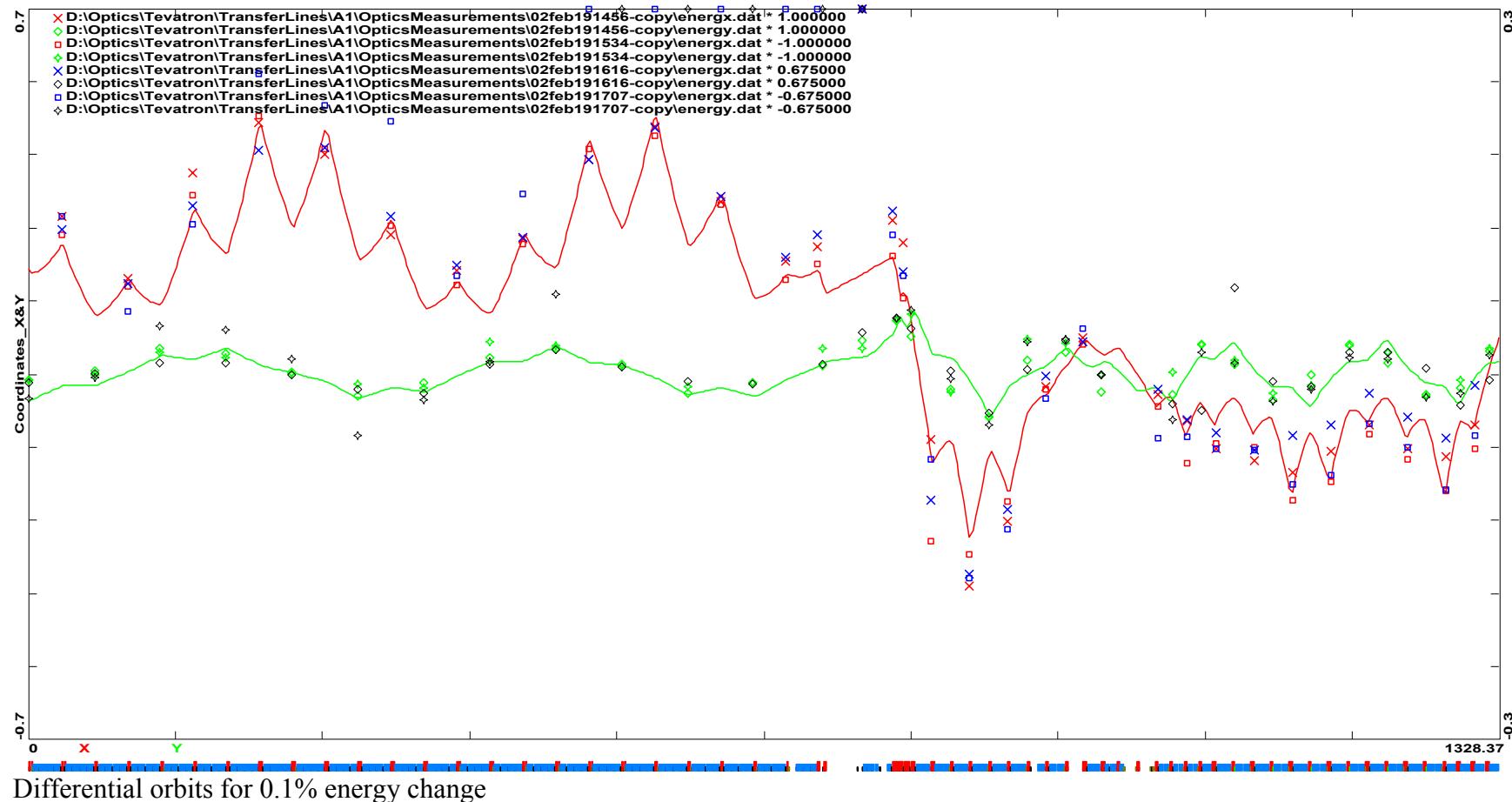
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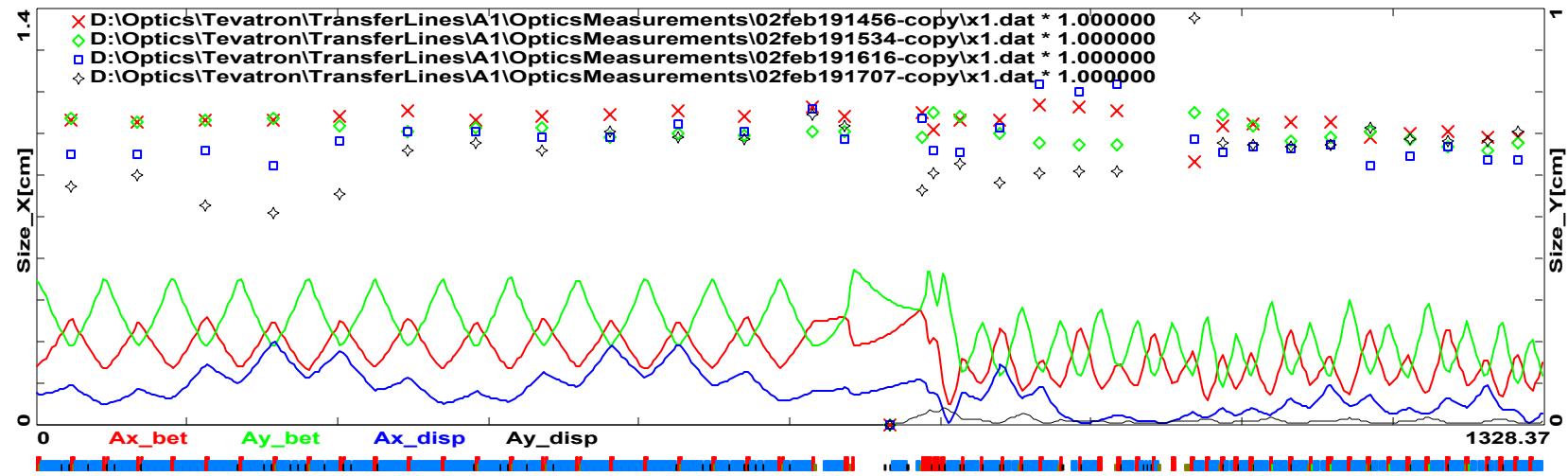
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Wed Feb 20 10:58:10 2002 OptiM - MAIN: - D:\Optics\Tevatron\TransferLines\A1\al1extb_1.opt

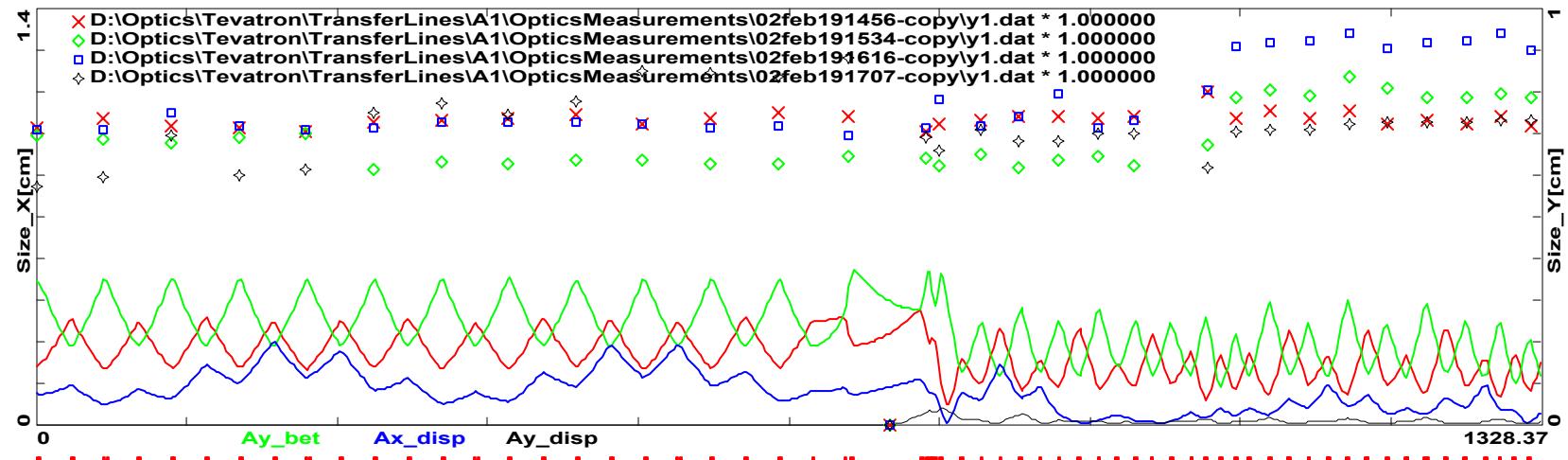


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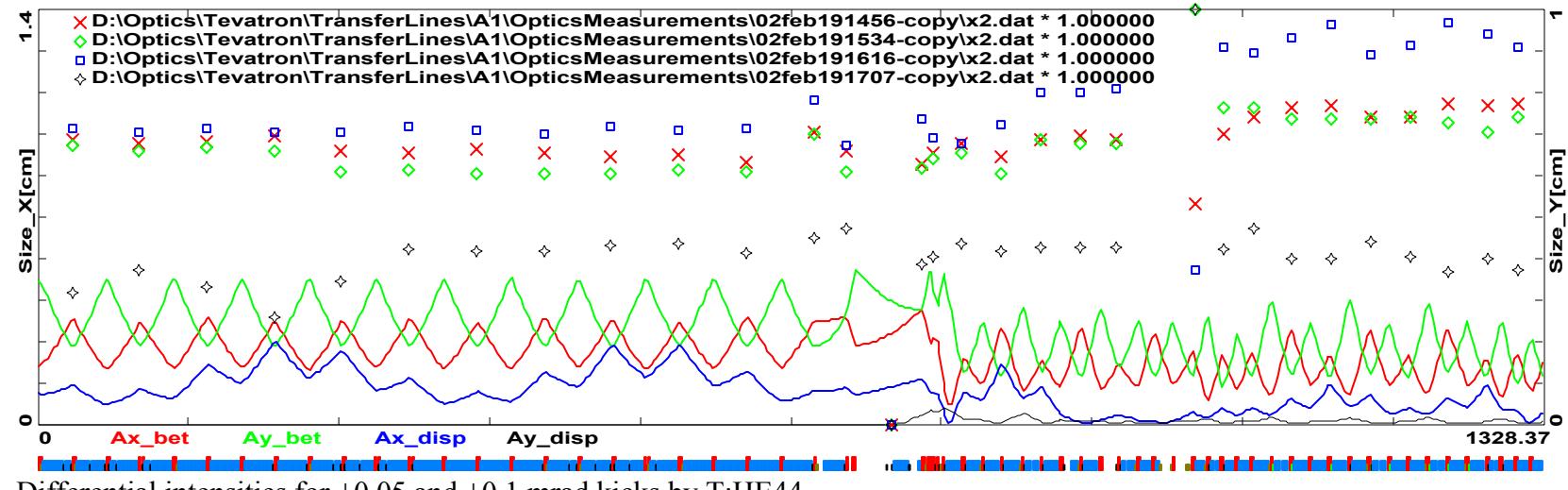
Differential intensities for ± 0.05 and ± 0.1 mrad kicks by T:HE42

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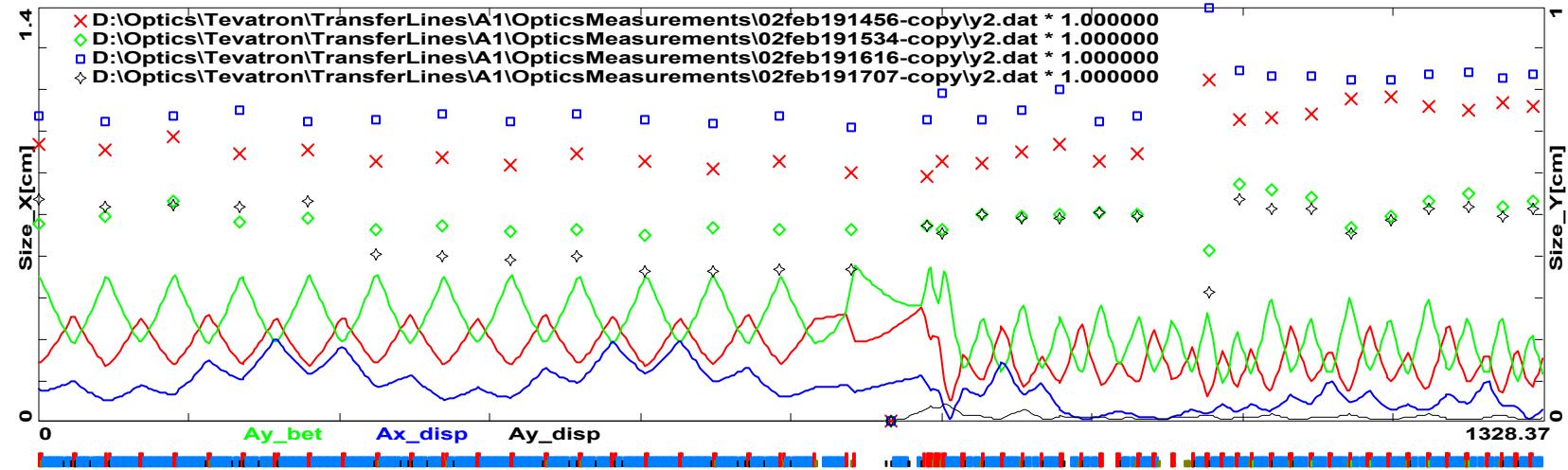


Differential intensities for ± 0.05 and ± 0.1 mrad kicks by T:VE47

Wed Feb 20 11:58:42 2002 OptiM - MAIN: - D:\Optics\Tevatron\TransferLines\A1\aaextb_1.opt

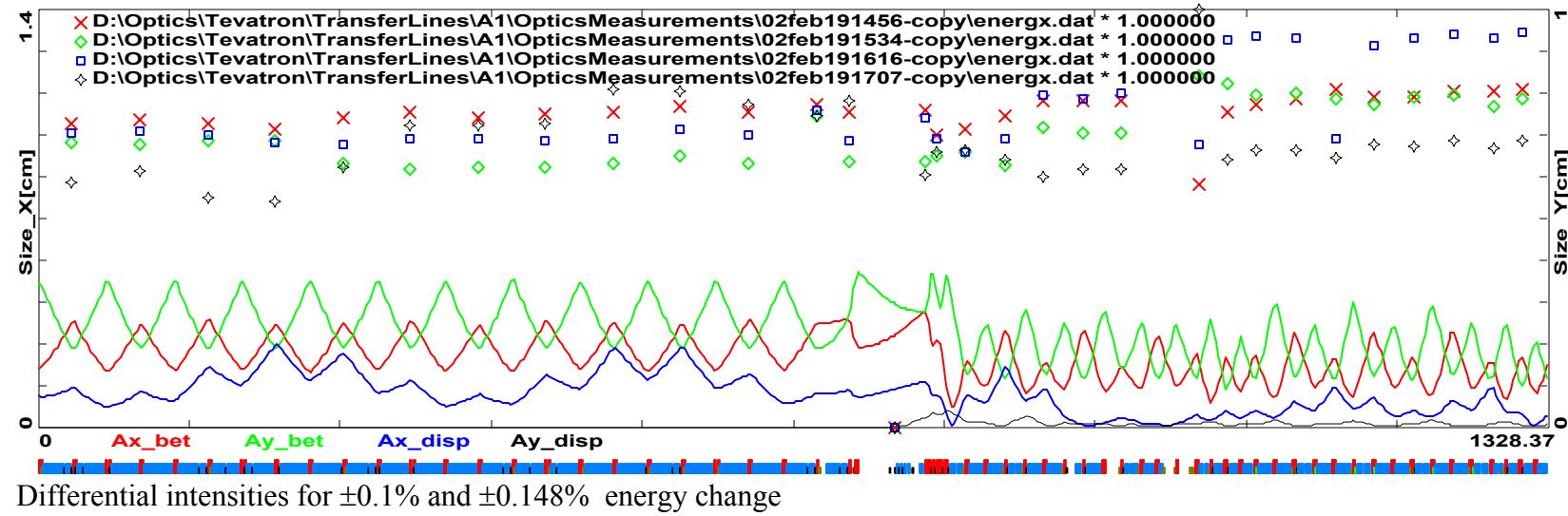


Differential intensities for ± 0.05 and ± 0.1 mrad kicks by T:HE44



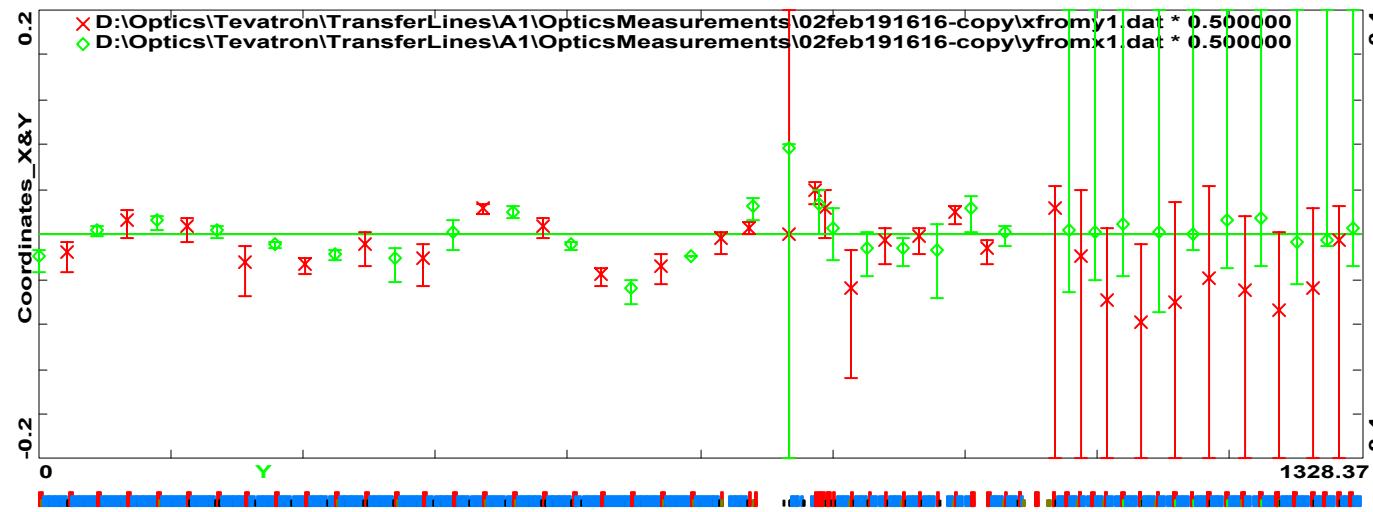
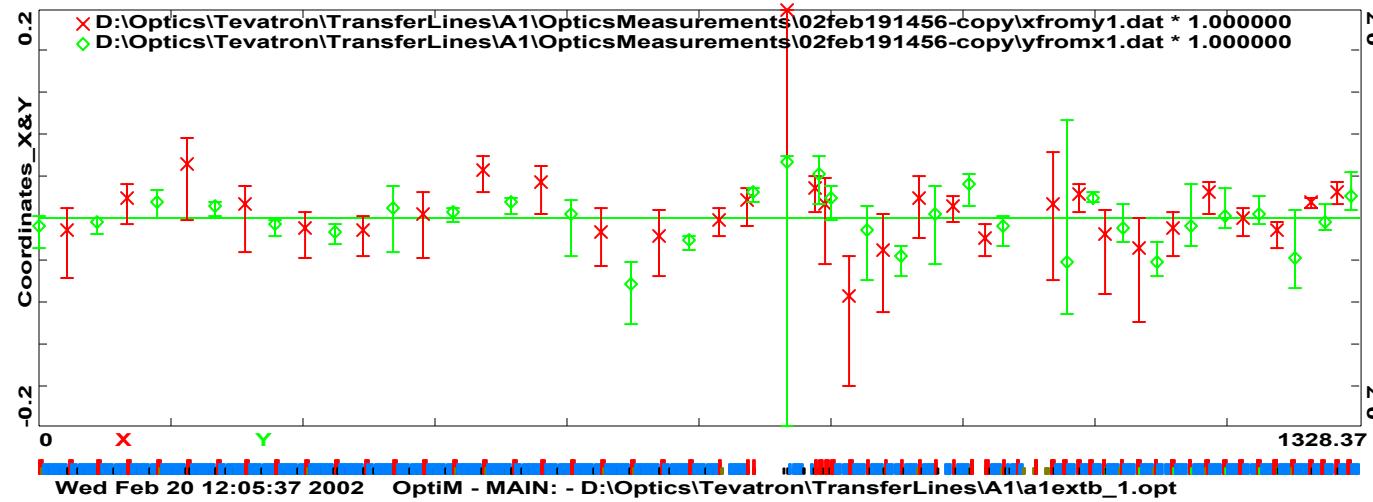
Differential intensities for ± 0.05 and $+0.1$ mrad kicks by T:VE49

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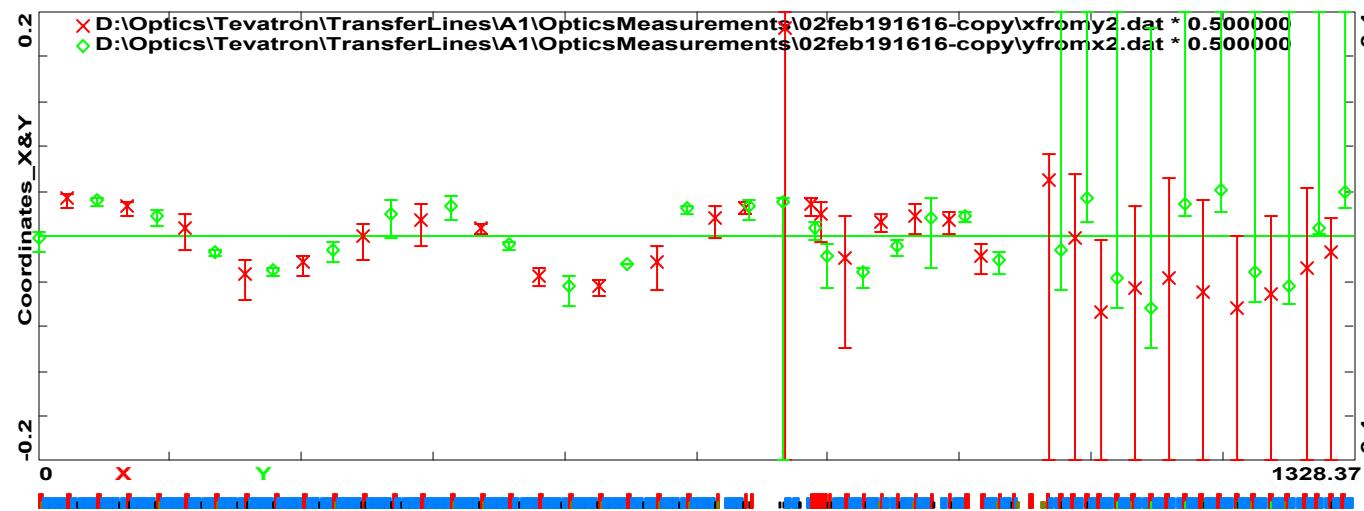
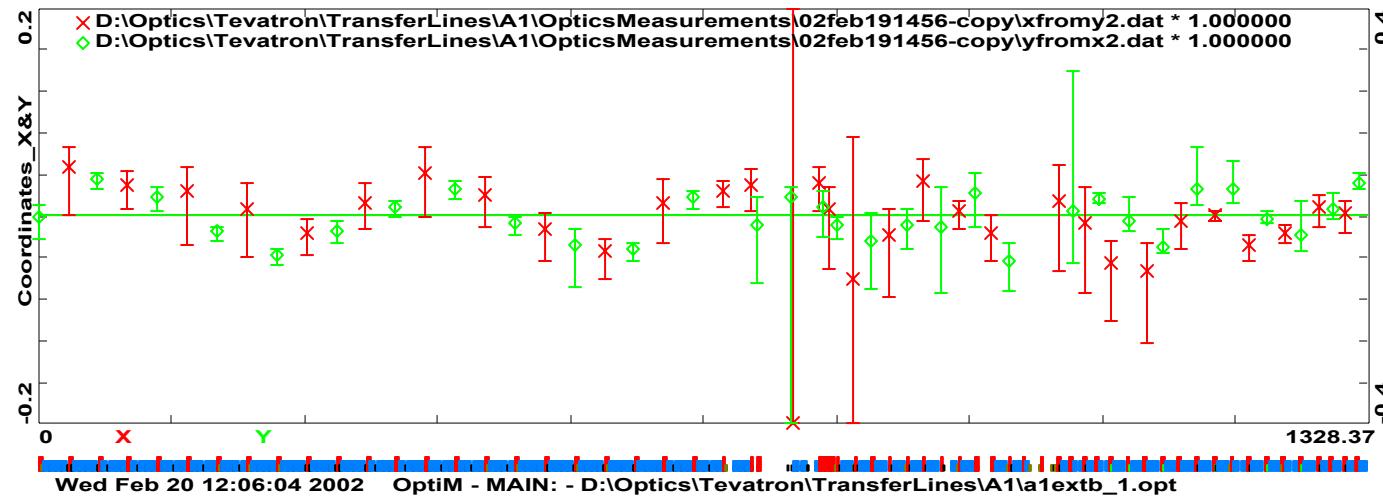
Differential intensities for $\pm 0.1\%$ and $\pm 0.148\%$ energy change

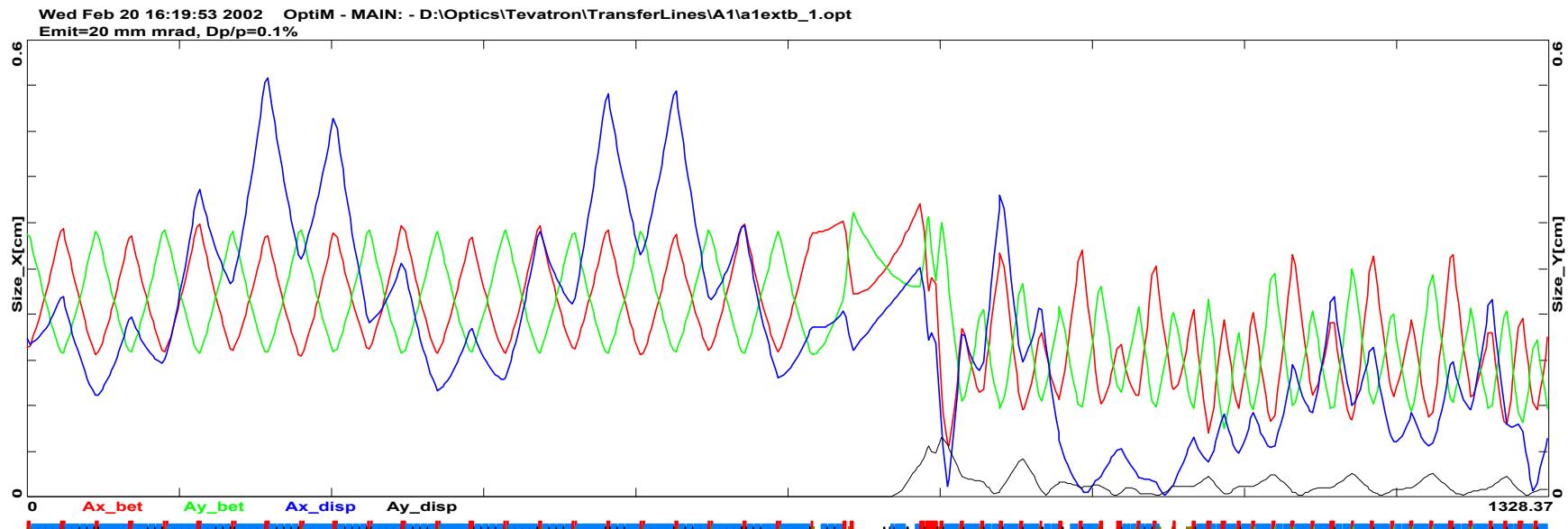
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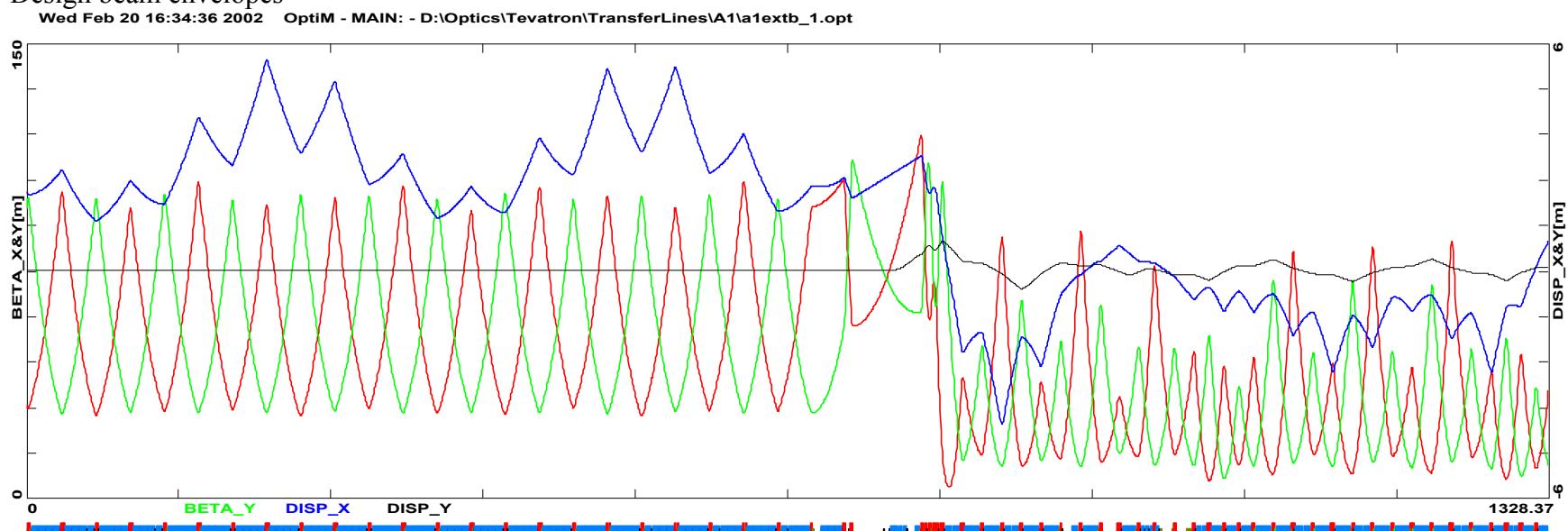
Coupled differential orbits for 0.05 and 0.1 mrad kick by T:HE42, and T:VE47

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Design beam envelopes



Design beta-functions and dispersions